"Epidemiology of Health" on the Central Nervous System (CNS) Development in Primary School Children

— Using the DE-Visual Sequential Memory Test as the CNS Developmental Index —

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Synopsis : The purpose of this study is to elucidate the various conditions for sufficient development of children's central nervous systems (CNS), especially paying attention to the children's daily life and their daily activities by the methodology of epidemiological study. It may be difficult to find out clearly the correlation between the conditions of CNS development and daily life. However the authors tried to examine the above mentioned relationship.

The subjects of this study were 757 B primary school children inTsukuba-gun Ibaraki prefecture.

The authors used the DE-Visual Sequential Memory Test (DE-VSM) as an index for children's simplified CNS development.

We divided these 757 children into the following three groups for the sake of convenience based upon the result of DE-VSM.

Group A: upper group; score of DE-VSM is higher than average.

Group B: average group; score of DE-VSM is average or less but higher than (M-1 S.D.)

Group C: lower group; score of DE-VSM is lower than (M-1 S.D.)

The authors analyzed what kind of characteristics these three groups have according to the method of epidemiological study. In order to study the conditions for children's CNS development, We carried out following survey:

1) Daily life at home: Children's activities and behavior (questionnaire)
2) Result of school health examination
3) Result of sport test in school (integrated evaluation)
4) Record of each subject in school

The result of this study elucidated (though not sufficiently) the conditions of children's CNS development.

We considered that this study belongs to the research of "epidemiology of health" concerning the CNS development and proved that the simplified DE-VSM is usable for a large group of children for epidemiological study.

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Introduction

Conditions which cause brain disorders such as cerebral palsy, mental retardation, epilepsy, and minimal brain dysfunction (MBD) have already been reasonably elucidated. This contributes greatly to the progression of the prevention of children's brain disorders. In recent years, the importance of a study concerning the conditions which brings "good health" has become emphasized against the epidemiology for searching the etiology of "diseases". This study searching for good health is called "epidemiology of health." The epidemiology of health is a study to find out the methods of both maintenance and improvement of health. In other words, preventing the diseases and improving health are considered better and more advantageous than the treatment after diseases have set in. Epidemiology of health was advocated by the above mentioned conception.

The epidemiology concerning the children's CNS development is a new study field. The author's research group has been studying the conditions for children's sufficient CNS development and tried to find out these conditions but as of today they are not elucidated enough. In particular, the analysis of the conditions concerning children's daily life activities are insufficient.

The purpose of this study is to elucidate the various conditions for sufficient development of children's CNS, especially paying attention to the children's daily life and their daily activities by using the method of epidemiological study.

Subjects and Method

Subjects in this study are 757 children in B primary school in Tsukuba-gun, Ibaraki Prefecture. Table 1 shows their distribution by age and sex.

Table 1. **Subjects**

sex \ age	6	7	8	9	10	11	12	total
boy	31	57	64	56	65	62	56	391
girl	25	57	47	48	51	72	66	366
total	56	114	111	104	116	134	122	757

In this study, DE-Visual Sequential Memory Test (DE-VSM) is used as a CNS development index.

DE-VSM is the simplified developmental test of visual sequential memory for a group of children. It consists of 10 items and it is possible to examine visual sequential memory in a short time. In DE-VSM, the required time to administer this test a child is about two minutes forty seconds on the average.

For convenience, the authors divided 757 children into the following 3 groups by the result of DE-VSM.

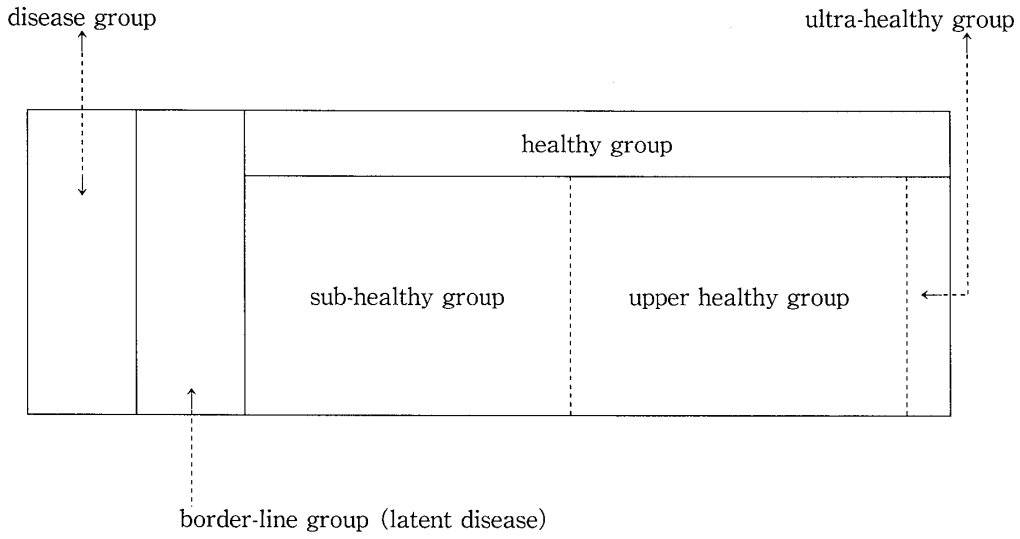
Group A: upper group; score of DE-VSM is higher than average.

Group B: average group; score of DE-VSM is average or less but higher than (M-1 S.D.)
Group C: lower group; score of DE-VSM is lower than (M-1 S.D.)

Meanwhile the authors show a structure of general population by health level in Figure 1. According to this figure, "A group" belongs to upper healthy group, "B group" belongs to sub-healthy group plus some part of border-line group, "C group" belongs to border-line group plus disease group.

The authors analyzed according to the method of epidemiology what kind of characteristics each of the above mentioned three group of A, B, and C has. Especially we wanted to elucidate how A group differs from group B and C. In fact most of the above mentioned B group children have developed as normal children. As shown in Figure 1, the sub-healthy group, upper-healthy group and ultra-healthy group are generally acknowledged as being healthy.

Figure 1. Structure of general population by health level



In the past, the "epidemiology of health" has been mainly concerned with the study of the ultra-healthy group. However, ultra-healthy group are in fact very few in a general population. Therefore it is difficult to use the ultra-healthy group as the subjects of epidemiological study and it is not very productive research. In addition there are not very many villages and towns where healthy aged people older than 100 years live.

Most clinical researchers have been interested in the disease group and border-line group for their epidemiological study, even though the disease group is not also a large number of the general population. But every one goes to clinics and hospitals when he or she has a disease. Therefore it is natural to develop the study of the "epidemiology of disease."

The epidemiology of disease could help greatly in the progression of medical research and contribute to the prevention of disease through its research findings.

Present school health can be considered to be the school health for minimal symptoms. It is well known that improvement of economic conditions, progression of medicine and nutrition resulted in the decline of the percentages of infectious diseases and serious diseases.

However, diseases which are not considered serious such as school refusal, epilepsy, allergic rhinitis and kyphoscoliosis have not decreased. Rather some of them are increasing these days. These mild symptoms such as learning disability, obesity, anorexia, and easily falling down (face breaking) are now the main problems in school health.

Considering the above mentioned characteristics of the health problems for present children, it is meaningful to compare groups of A, B, and C according to the method of epidemiology. In order to study the conditions for children's CNS development the authors carried out the following survey:

1) Daily life at home : children's activities and behavior (questionnaire)
2) Result of school health examination
3) result of sport test in school (integrated evaluation of 5th and 6th grade children)
4) record of each subject in school

In examining the relationship between the above mentioned conditions for children's CNS development and result of DE-VSM, we utilized x^2 test. We also studied the correlation between the DE-VSM score and the DE-BGT score, which was developed by the author's group as one of the screening tests for neurological disorders.

Results and discussion

1. Correlation relating the daily life at home (children's activities and behavior) and the results of the DE-VSM.

Among the many items of the survey for daily life at home, the following four items showed signifcant relationship with the score of DE-VSM.

a) Regularity of children's meal taking.
b) Whether or not taking breakfast.
c) The kind of crammer school attended.
d) The length of time watching TV.

a) Correlation between regularity of meal time and DE-VSM score.

Among 150 A group girls 145 girls (96.7%) took breakfast regularly. The B group showed the same percentage 113 (96.6%) out of 117 girls. The C group ; 41 (78.8%) out of 52 girls.

There was significant difference between A, and C. ($p<0.005$).

Children who took breakfast regularly tend to have a good result of the DE-VSM as shown in Table 2.

b) Correlation between the breakfast taking and DE-VSM score.

Among 112 B group girls 108 (96.4%) girls took breakfast without fail. 37 (71.2%) out of 52 C group girls took breakfast as shown in Table 3. There was significant differences between B and C. ($p< 0.005$).

The children who took breakfast without fail showed good result of the DE-VSM.

c) Correlation between the kind of crammer school attended and the DE-VSM score (duplicated answers).

Among 90 A group boys 19 (21.1%) boys attended the crammer school of language or English. 13

Table 2. Correlation between regularity of meal time and DE-VSM score

taking a meal regularly or not / DE-VSM score		cases	regularity frequency	%	irregularity frequency	%
	A	184	172	93.5	12	6.5
boy	B	108	101	93.5	7	6.5
n=354	C	62	58	93.5	4	6.5
***	A	150	145	96.7	5	3.3
girl	B	117	113	96.6	4	3.4
n=319	C	52	41	78.8	11	21.2
**	A	334	317	94.9	17	5.1
total	B	225	214	95.1	11	4.9
n=673	C	114	99	86.8	15	13.2

注) * P<0.05
** P<0.01
*** P<0.005

Table 3. Correlation between breakfast taking and DE-VSM score

condition of taking breakfast / DE-VSM score		cases	take breakfast without fail frequency	%	don't take breakfast when busy frequency	%	don't take breakfast at all frequency	%
	A	185	169	91.4	13	7.0	3	1.6
boy	B	110	100	90.9	6	5.5	4	3.6
n=361	C	66	61	92.4	4	6.1	1	1.5
***	A	149	137	91.9	11	7.4	1	0.7
girl	B	112	108	96.4	2	1.8	2	1.8
n=313	C	52	37	71.2	13	25.0	2	3.8
***	A	334	306	91.6	24	7.2	4	1.2
total	B	222	208	93.7	8	3.6	6	2.7
n=674	C	118	98	83.1	17	14.4	3	2.5

注) *** P<0.005

(23.2%) out of 56 B group boys and 1 (2.6%) out of 39 C group boys attended the crammer school of language or English as shown in Table 5. There was significant difference between A and B, and between B and C. ($p < 0.05$).

Among 90 A group boys 51 (56.7%) attended the crammer school of Art (piano, Painting, and calligraphy). 27 (69.2%) out of 39 C group boys attended above mentioned crammer school. We can hardly think that there is any causal relationship between crammer school attending and DE-VSM score. The authors considered that the children whose result of the DE-VSM were bad

Table 4. **Correlation between the kind of crammer school attended and the DE-VSM score (duplicated answers)**

kind of attended crammer / DE-VSM score		cases	abacus and/or math.		art: {piano, painting, calligraphy}		language and/or English		swimming		others	
			frequency	%	frequency	%	frequency	%	frequency	%	frequency	%
	A	90	51	56.7	51	56.7	19	21.1	14	15.6	3	3.3
		(138)		(37.0)		(37.0)		(13.8)		(10.1)		(2.2)
boy	B	56	31	55.4	* 41	73.2	* 13	23.2	5	8.9	1	1.8
		(91)		(34.1)		(45.1)	*	(14.3)		(8.9)		(1.1)
	C	39	17	43.6	27	69.2	1	2.6	2	5.1	1	2.6
n=185		(48)		(35.4)		(56.3)		(2.1)		(4.2)		(2.1)
	A	118	46	39.0	122	103.4	18	15.3	14	11.9	6	5.1
		(206)		(22.3)		(59.2)		(8.7)		(6.8)		(2.9)
girl	B	85	35	41.2	92	108.2	18	21.2	7	8.2	5	5.9
		(157)		(22.3)		(58.6)		(11.5)		(4.5)		(3.2)
	C	39	17	43.6	38	97.4	5	12.8	3	7.7	1	2.6
n=242		(64)		(26.6)		(59.4)		(7.8)		(4.7)		(1.6)
	A	208	97	46.6	173	83.2	37	17.8	28	13.5	9	4.3
		(344)		(28.2)		(50.3)		(10.6)		(8.1)		(2.6)
total	B	141	66	46.8	133	94.3	31	22.0	12	8.5	6	4.3
		(248)		(26.6)		(53.6)		(12.5)		(4.8)		(2.4)
	C	78	34	43.6	65	83.3	6	7.7	5	6.4	2	2.6
n=427		(112)		(30.3)		(58.0)		(5.4)		(4.5)		(1.8)

注) $*P<0.05$

had attended the crammer school of art.

d) Correlation between the length of time for watching television and the DE-VSM score.

Among the total number of 220 boys and girls of B group 99 (45%) watched television more than 2 hours every day. C group; 88 (57.5%) out of 153. There was significant difference between B and C. ($p< 0.05$) as shown in Table 5.

Children who don't watch television for a long time might use their time usefully for studying and playing

The authors studied other items of the survey in addition to the above mentioned survey. They are as follows: the hour of rising, the children's conditions at the time when they get up, the conditions of the time when children go to school, the family who they take meals with, friends who they play with, the order of birth, existence of parents (whether they live together or not) and parents' (father's, or mother's) occupation. But there were no significant relationships between the above mentioned items and DE-VSM score.

Table 5. Correlation between the lenght of time for watching TV and the DE-VSM score

lenght of time for watching TV / DE-VSM score		cases	0 hour ~ 2 hours frequency	%	2 hours and more frequency	%
	A	176	89	50.6	87	49.4
boy	B	106	55	51.9	51	48.1
n=361	C	79	38	48.1	41	51.9
*	A	131	64	48.9	67	51.1
girl	B	113	66 *	58.4	47 *	41.6
n=318	C	74	27 *	36.5	47 *	63.5
	A	307	153	49.8	154	50.2
total	B	220	121 *	55.0	99 *	45.0
n=680	C	153	65 *	42.5	88 *	57.5

注) * $P<0.05$
** $P<0.01$

2. Correlation between the school health examination results and DE-VSM score.

The authors examined the correlation coefficient relating the result of school health examination in school and the DE-VSM score. Among all the items in the school health examination, only the otorhinolaryngological state showed the relationship with the score of DE-VSM.

Among 154 A group girls 18 (11.7%) had chronic sinusitis or otitis as shown in Table 6. While in C group, 13 (24.5%) out of 53 girls had the same diseases. There was significant difference between A and C as shown in table 6 ($p<0.05$). The children without the above mentioned diseases

Table 6. Correlation between the school health examination results and DE-VSM score (otorhinolaryngological state)

otorhinolaryngological state / DE-VSM score		cases	having disease frequency	%	not having disease frequency	%
	A	191	23	12.0	168	88.3
boy	B	115	18	15.7	97	84.3
n=372	C	66	9	13.6	57	86.4
*	A	154	18	11.7	136	88.3
girl	B	123	13 *	10.6	110 *	89.4
n=330	C	53	13 *	24.5	40 *	75.5
	A	345	41	11.9	304	88.1
total	B	238	31	13.0	207	87.0
n=702	C	119	22	18.5	97	81.5

注) * $P<0.05$

showed better result of DE-VSM score than the children who have otorhinolaryngological diseases.

We examined other items of the school health examinations such as height, weight, chest girth, acuity of vision (right and left), eye disease and Rohrer's index. However, there was no correlation relating the result of DE-VSM score and above mentioned items.

3. Correlation between the sport test and DE-VSM score.

The authors divided the children into three group of upper group, average group and lower group according to the result of the sport test. Upper group consists of children who scored in the 1st and 2nd grades in officially standardized sport test. The average group consists of children; 3rd and 4th, and lower group; 5th and 6th. Among 57 A group girls 19 (33.3%) belonged to the upper group, while 6 (13.0%) out of 46 B group girls belonged to the upper group. There was significant difference between A and B ($p<0.05$.)

Table 7. **Correlation between the sport test and DE-VSM score**

sport test result / DE-VSM score		cases	upper group 1'st and 2'd grade		average group 3'd and 4'th grade		lower group 5th and 6th grade	
			frequency	%	frequency	%	frequency	%
	A	52	10	19.2	29	55.8	13	25.0
boy	B	36	11	30.6	15	41.7	10	27.8
n=106	C	18	3	16.7	10	55.5	5	27.8
*	A	57	19	33.3	29	50.9	9	15.8
girl	B	46	6 *	13.0	30	65.3	10	21.7
n=119	C	16	1	6.3	11	68.7	4	25.0
	A	109	29	26.6	58	53.2	22	20.2
total	B	82	17	20.7	45	54.9	20	24.4
n=225	C	34	4	11.8	21	61.7	9	26.5

注) $*P<0.05$

4. Correlation between the subject's record in school and the DE-VSM score.

There was significant correlation between all the subjects' records in school and the score of DE-VSM.

Among these significant data obtained, Table 8 and Table 9 showed the correlation between the subjects (physical education and music) and DE-VSM score.

Authors considered that the CNS development of children are closely related to the record of the subjects in school.

Table 8. **Correlation between the physical education record in school and DE-VSM score**

physical education record / DE-VSM score		cases	lower group frequency	%	average group frequency	%	upper group frequency	%
	A	191	27	14.1	102	53.4	62	32.5
boy	B	115	23	20.0	55	47.8	37	32.2
n=374	C	68	13	19.1	34	50.0	21	30.9
***	A	153	16	10.5	72	47.0	65	42.5
girl	B	122	29	23.8	56	45.9	37	30.3
n=329	C	54	18	33.3	27	50.0	9	16.7
***	A	344	43	12.5	174	50.6	127	36.9
total	B	237	52	21.9	111	46.9	74	31.2
n=703	C	122	31	25.4	61	50.0	30	24.6

注) ** P<0.01
*** P<0.005

Table 9. **Correlation between the music record in school and DE-VSM score**

music record / DE-VSM score		cases	lower group frequency	%	average group frequency	%	upper group frequency	%
***	A	191	33	17.3	120	62.8	38	19.9
boy	B	115	41	35.7	56	48.6	18	15.7
n=374	C	68	27	39.7	34	50.0	7	10.3
***	A	153	3	2.0	62	40.5	88	57.5
girl	B	122	7	5.7	58	47.6	57	46.7
n=329	C	54	5	9.3	33	61.1	16	29.6
***	A	344	36	10.5	182	52.9	126	36.6
total	B	237	48	20.3	114	48.1	75	31.6
n=703	C	122	32	26.2	67	54.9	23	18.9

注) * P<0.05
*** P<0.005

5. Correlation between the DE-BGT score and DE-VSM score.

Among the total number of 345 A group children 150 (43.5%) belonged to in the upper group of the DE-BGT score. While C group; 39 (32.0%) out of 122 boys and girls belonged to upper group of the DE-BGT score.

This result was a matter of course, because the DE-VSM and the DE-BGT were both simplified developmental indices for the CNS development.

Table 10. **Correlation between the DE-BGT score and the DE-VSM score**

DE-BGT score / DE-VSM score		cases	upper group frequency	%	average group frequency	%	lower group frequency	%
	A	191	75	39.3	68	35.6	48	25.1
boy	B	116	42	36.3	33	28.4	41 *	35.3
n=375	C	68	25	36.7	21	30.9	22	32.4
* *	A	154	76 *	49.4	53	34.4	25 *	16.2
girl	B	124	46 * *	37.1	40	32.3	38 * *	30.6
n=332	C	54	14 *	25.9	22	40.8	18	33.3
*	A	345	150	43.5	121	35.1	74 *	21.4
total	B	240	88 *	36.7	74	30.8	78 * *	32.5
n=707	C	122	39	32.0	44	36.0	39	32.0

注) * P<0.05
* * P<0.01
* * * P<0.005

References

1. Shoji O., Mukai Y., et al : Study on the Standardization of De-Visual Sequential Memory Test (VSM), Standard Value of the DE-VSM in the Primary school children, J. of Ryutsu Keizai Univ., Vol. 28, 2, pp73-84, 1993.
2. Shoji O., Mukai Y., et al : Study on the Standardization of DE-VSM, Validity and Reliability of the DE-VSM in Primary school children, J. of Ryutsu Keizai Univ., Vol. 28, No. 4, pp51-61, 1994.
3. Shoji O., Onuma J., Mukai Y. et al : Study of the Simplified Motor Function Test for Children, Standard Value of DEMT for Children Aged 3-6, J. of Ryutsu Keizai Univ., Vol. 25, 2, pp27-39, 1990.
4. Shoji O., Kitami R., Mukai Y. et al : Study of the Simplified Motor Function Test for Children, Validity and Reliability of DEMT for Children Aged 3-6, J. of Ryutsu Keizai Univ., Vol. 25, 3, pp39 -50, 1990.
5. Shoji O., Sumita C., Mukai Y. : Study of the Cause of Insufficient Predictive Validity of Developmental Tests, J. of Ryutsu Keizai Univ., Vol. 25, 3, pp39-50, 1990.
6. Shoji O., Suzuki N., Mukai Y. : Proposal of a New Method in the Prognostic Study of Neuro-pediatric Disorders, J. of Ryutsu Keizai Univ., Vol. 26, 1, pp11-18, 1991.
7. Shoji O., Kikuchi E., Mukai Y. : Developmental Neuro-Epidemiologic Study on Criteria of Normal High School Students, J. of Ryutsu Keizai Univ., Vol. 26, 2, pp30-40, 1991.
8. Shoji O., Ando C., Mukai Y., Standard Value of the DE-Bender Gestalt Test in Primary School Children, J. of Ryutsu Keizai Univ., Vol. 27, 1, pp17-29, 1992.
9. Mukai Y. : Proposal of Developmental Epidemiology, Jap. J. of School Health, Vol. 25, No.5 pp165-168, 1983.

10. Mukai Y.: Development of School Health for Minimal Symptoms, J. of School Health, Vol. 30, 4, pp162-168, 1988.
11. Ono E., Mukai Y. et al: Study on a Simplified Motor Function Test of High School Students, The Standard Value of DEMT for High School Students Jap. J. of School Health, Vol. 23, 6, pp286-294, 1981.
12. Hashimoto Y., Mukai Y. et al: Study on a Simplified Motor Function Test, The Validity and Reliability of DEMT for High School Students, Jap. J. of School Health, Vol. 23, 6, pp444-450, 1981.
13. Mukai Y.: Manual of MN-Developmental Screening Test, with Special Reference to Developmental Neuro-Epidemiology, New Medical Sha, Mito, pp8-118, 1982.
14. Kawakita E., Mukai Y, et al: DE-Bender Gestalt Test (BGT) for High School Students, Standard Value of DE-BGT, J. of Ibaraki Univ. Education Faculty, Vol. 28, 3, pp97-110, 1979.
15. Hashimoto Y., Mukai Y. et al: DE-BGT for High School Students, Validity and Reliability of DE-BGT, J. of Ibaraki Univ. Education Faculty, Vol. 28, pp111-122, 1979.